[Name of Document] Patent Application
[Reference Number] 549564JP01
[Filing Date] February 13, 2004
[Addressed to] Commissioner, Patent Office
[International Patent Classification] G09F 9/00
[Inventor]
[Address] c/o Mitsubishi Electric Corporation,
2-3, Marunouchi 2-chome, Chiyoda-ku, Tokyo
[Name] Akimasa YUUKI
[Inventor]
[Address] c/o Mitsubishi Electric Corporation,
2-3, Marunouchi 2-chome, Chiyoda-ku, Tokyo
[Name] Kyoichiro ODA
[Inventor]
[Address] c/o Mitsubishi Electric Corporation,
2-3, Marunouchi 2-chome, Chiyoda-ku, Tokyo
[Name] Atushi ITO
[Applicant for Patent]
[Identification Number] 000006013
[Name] Mitsubishi Electric Corporation
[Attorney]
[Identification Number] 100066474
[Patent Attorney]
[Name] Hiroaki TAZAWA
[Authorized Agent]
[Identification Number] 100088605
[Patent Attorney]
[Name] Masanobu KATO
[Authorized Agent]
[Identification Number] 100123434
[Patent Attorney]
[Name] Hideaki TAZAWA
[Authorized Agent]
[Identification Number] 100101133
[Patent Attorney]
[Name] Hatsune HAMADA
[Information on the fees]

[Register Number of Deposit in Advance]		020640
[Amount of Deposit]		¥21,000
[List of the Attached Documents]		
[Name of the Document]	Claims	1
[Name of the Document]	Specification	1
[Name of the Document]	Drawings	1
[Name of the Document]	Abstract	1

[NAME OF THE DOCUMENT] SCOPE OF THE PATENT CLAIMS

[Claim 1]

A liquid crystal display including a liquid crystal panel having two screens, a first front light placed in a vicinity of one of the two screens of said liquid crystal panel, a second front light placed in a vicinity of the other one of the two screens of said liquid crystal panel, and a pixel driving circuit for driving pixels of said liquid crystal panel to display an image on said liquid crystal panel, characterized in that said pixel driving circuit alternately displays a first image and a second image on said liquid crystal panel, and said first front light lights up while the first image is displayed on said liquid crystal panel by said pixel driving circuit, and said second front light lights up while the second image is displayed on said liquid crystal panel by said pixel driving circuit.

[Claim 2]

The liquid crystal display according to Claim 1, characterized in that when displaying the first or second image on the liquid crystal panel, the pixel driving circuit applies image data about the image to be displayed on the liquid crystal panel to a plurality of gate lines of the liquid crystal panel in turn, and the first or second front light lights up after the image data has been applied to all the gate lines.

[Claim 3]

The liquid crystal display according to Claim 1, characterized in that in a case where each of the first and second front lights includes a plurality of light sources, when displaying the first or second image on the liquid crystal panel, the pixel driving circuit applies image data about the image to be displayed on the liquid crystal panel to a plurality of gate lines of the liquid crystal panel in turn to cause the plurality of light sources which respectively correspond to the plurality of gate lines to light up in order that the image data is applied to the plurality of gate lines.

[Claim 4]

The liquid crystal display according to any one of Claim 1 to Claim 3, characterized in that the liquid crystal panel includes a liquid crystal cell having the plurality of pixels, a pair of transparent glass substrates which sandwich said liquid crystal cell, and a pair of polarizing plates placed outside said pair of transparent glass substrates.

[Claim 5]

Information equipment provided with a liquid crystal display in which a first front light is placed on a vicinity of one of two screens of a liquid crystal panel, a second front light is placed on a vicinity of the other one of the two screens of said liquid crystal panel, and a pixel driving circuit for driving pixels of said liquid crystal panel to display an image on said liquid crystal panel is disposed, and an image controller for

outputting image data about the image which is to be displayed on said liquid crystal panel to said pixel driving circuit, characterized in that when receiving image data about a first image and image data about a second image from said image controller, said pixel driving circuit alternately displays the first and second images on said liquid crystal panel, and said first front light lights up while the first image is displayed on said liquid crystal panel by said pixel driving circuit, and said second front light lights up while the second image is displayed on said liquid crystal panel by said pixel driving circuit.

[NAME OF THE DOCUMENT] SPECIFICATION

[TITLE OF THE INVENTION] LIQUID CRYSTAL DISPLAY AND INFORMATION EQUIPMENT

[TECHNICAL FIELD]

[0001]

The present invention relates to a liquid crystal display which displays images on a liquid crystal panel having two screens, and information equipment, such as a mobile phone, a portable electronic notebook (PDA), or a wrist watch, which is equipped with the liquid crystal display.

[BACKGROUND ART]

[0002]

Conventionally, there have been provided reflective liquid crystal displays and semitransparent reflective liquid crystal displays. Any of such reflective liquid crystal displays and semitransparent reflective liquid crystal displays has only one screen.

Therefore, for example, when there is a request that screens are mounted on both an inside surface and an outside surface of a folding type mobile phone, respectively, there's no other choice but to mount two liquid crystal displays in the mobile phone.

This results in increase in the thickness of the display unit of the mobile phone and hence increase in the weight of the mobile phone. Furthermore, the mounting of two liquid crystal displays in the mobile phone increases the cost of the mobile phone.

[0003]

Then, development of a liquid crystal display having two screens has been requested, and such a liquid crystal display has been provided.

For example, there has been provided a liquid crystal display in which a first reflective polarizer and a first absorptive polarizer are placed in the vicinity of one screen of a liquid crystal cell, and a second reflective polarizer and a second absorptive polarizer are placed in the vicinity of another screen of the liquid crystal cell.

In this liquid crystal display constructed as mentioned above, the same image is displayed on both the front screen and back screen of the liquid crystal cell (refer to, for example, patent reference 1).

[0004]

[Patent reference 1] JP,2000-193956,A (see paragraphs [0026] to [0071], and Fig. 1)

[DESCRIPTION OF THE INVENTION]

[PROBLEM TO BE SOLVED BY THE INVENTION]

[0005]

A problem with the related art liquid crystal display constructed as mentioned above is that while it can display an image on both the screens, it cannot display another image different from the image currently being displayed on one screen on the other screen.

[0006]

The present invention is made in order to solve the above-mentioned problem, and it is therefore an object of the present invention to provide a liquid crystal display which can display another image different from an image currently being displayed on one screen on the other screen.

It is another object of the present invention to provide information equipment equipped with a liquid crystal display which can display another image different from an image currently being displayed on one screen on the other screen.

[MEANS FOR SOLVING THE PROBLEM]

[0007]

In accordance with the present invention, there is provided a liquid crystal display including a pixel driving circuit for alternately displaying a first image and a second image on a liquid crystal panel, in which a first front light lights up while the first image is displayed on the liquid crystal panel by the pixel driving circuit, and a second front light lights up while the second image is displayed on the liquid crystal panel by the pixel driving circuit.

[EFFECTS OF THE INVENTION]

[0008]

According to the present invention, since there is provided a pixel driving circuit for alternately displaying a first image and a second image on a liquid crystal panel, in which a first front light lights up while the first image is displayed on the liquid crystal panel by the pixel driving circuit, and a second front light lights up while the second image is displayed on the liquid crystal panel by the pixel driving circuit, the present invention offers an advantage of being able to display another image different from an image currently being displayed on one screen on the other screen.

[BEST MODE FOR CARRYING OUT THE INVENTION]

[0009]

Embodiment 1.

Fig. 1 is a cross-sectional view showing information equipment equipped with a liquid crystal display in accordance with embodiment 1 of the present invention. Although the information equipment in accordance with this embodiment 1 is a mobile phone, the information equipment is not limited to a mobile phone. For example, the information equipment in accordance with this embodiment 1 can be a portable electronic notebook (PDA), a wrist watch, or the like.

In the figure, function switches 2, such as operation keys which enable the user to perform various kinds of operations, as well as ten keys which enable the user to input numbers, characters, and so on, are mounted in a main body 1 of the mobile phone.

A display unit 3 of the mobile phone is coupled to the main body 1 via a hinge 4 so that the display unit can be freely folded or unfolded, and the liquid crystal display is mounted in the display unit 3.

[0010]

A liquid crystal panel 11 is provided with a liquid crystal cell having a plurality of pixels.

A front light 12 (or a first front light) is placed in the vicinity of a screen 11b of the liquid crystal panel 11, and lights up while a first image which a viewer A looks at is displayed on the liquid crystal panel 11. A front light 13 (or a second front light) is placed in the vicinity of another screen 11a of the liquid crystal panel 11, and lights up while a second image which a viewer B looks at is displayed on the liquid crystal panel 11.

A transparent cover 14 is disposed in an opening (or a window) formed in an inner surface of the display unit 3, and another transparent cover 15 is disposed in an opening (or a window) formed in an outer surface of the display unit 3.

[0011]

When receiving image data from an image controller 17 of the mobile phone, a pixel driving circuit 16 applies the image data to each pixel of each of a plurality of gate lines of the liquid crystal panel 11 so as to display the image on the liquid crystal panel 11. When receiving image data about a first image and image data about a second image from the image controller 17, the pixel driving circuit 16 alternately displays the first and second images on the liquid crystal panel 11.

The image controller 17 outputs the image data according to, for example, an operation of the function switches 2, the transmission-and-reception status of a telephone call or an e-mail, and so on to the pixel driving circuit 16, and controls the switching on and off of each of the front lights 12 and 13.

[0012]

Fig. 2 is a cross-sectional view showing the liquid crystal panel 11 of the liquid crystal display in accordance with embodiment 1 of the present invention. In the figure, the liquid crystal cell 21 has a plurality of pixels, and the liquid crystal cell 21 is sandwiched between a pair of transparent glass substrates 22. The perimeter of the liquid crystal cell 21 is sealed with sealing agents 23.

A pair of polarizing plates 24 are placed on the outer surfaces of the pair of transparent glass substrates 22, respectively, and polarize light emitted out of each pixel of the liquid crystal cell 21.

[0013]

Next, the operation will be explained.

In a state where the display unit 3 of the mobile phone is unfolded,

a viewer A can observe the screen 11a of the liquid crystal panel 11 through the transparent cover 14, while another viewer B can observe the screen 11b of the liquid crystal panel 11 through the transparent cover 15, as shown in Fig. 1.

[0014]

The image controller 17 of the mobile phone outputs image data according to, for example, an operation of the function switches 2, the transmission-and-reception status of a telephone call or an e-mail, and so on to the pixel driving circuit 16. For example, when a user operates the mobile phone so as to enable the viewer A to look at the first image and enable the viewer B to look at the second image, or a user operates the mobile phone so as to prevent the viewer B from looking at an image which the viewer A is looking at, the image controller 17 outputs the image data about the first image and the image data about the second image to the pixel driving circuit 16, and also outputs an image control signal for instructing an alternate display of the first and second images to the pixel driving circuit 16.

In addition, the image controller 17 outputs a light control signal for controlling the switching on and off of each of the front lights 12 and 13 to each of the front lights 12 and 13.

[0015]

While receiving the image data about the first image and the image data about the second image from the image controller 17 of the mobile phone, and also receiving the image control signal from the image controller 17, the pixel driving circuit 16 displays the first image on the liquid crystal panel 11 by applying the image data about the first image to each pixel of each of the plurality of gate lines 1 to N of the liquid crystal panel 11.

At this time, the front light 12 is made to light up according to the light control signal outputted from the image controller 17 while the first image is displayed on the liquid crystal panel 11.

As a result, the viewer A can look at the first image currently being displayed on the screen 11a of the liquid crystal panel 11 through the transparent cover 14.

On the other hand, since the front light 13 is switched off, the viewer B cannot look at the first image currently being displayed on the screen 11b of the liquid crystal panel 11 through the transparent cover 15.

[0016]

Here, Fig. 3 is an explanatory diagram showing a timing at which the first and second images are alternately written. In the figure, the horizontal axis shows time, and the vertical axis shows the transmissivity of each pixel of each of the plurality of gate lines 1 to N.

As can be seen from Fig. 3, the pixel driving circuit 16 applies the

image data about the first image to the plurality of gate lines 1 to N of the liquid crystal panel 11 in turn when displaying the first image on the liquid crystal panel 11. Since the front light 12 lights up simultaneously over the entire screen after the image data has been applied to all the gate lines 1 to N in turn, the first image is simultaneously displayed on the entire screen 11a of the liquid crystal panel 11.

[0017]

After displaying the first image on the liquid crystal panel 11 in the above-mentioned way, the pixel driving circuit 16 displays the second image on the liquid crystal panel 11 by applying the image data about the second image to each pixel of each of the plurality of gate lines 1 to N of the liquid crystal panel 11 after the front light 12 is switched off according to the light control signal.

At this time, the front light 13 is made to light up according to the light control signal outputted from the image controller 17 while the second image is displayed on the liquid crystal panel 11.

As a result, the viewer B can look at the second image currently being displayed on the screen 11b of the liquid crystal panel 11 through the transparent cover 15.

On the other hand, since the front light 12 is switched off, the viewer A cannot look at the second image currently being displayed on the screen 11a of the liquid crystal panel 11 through the transparent cover 14.

[0018]

As can be seen from Fig. 3, the pixel driving circuit 16 applies the image data about the second image to the plurality of gate lines 1 to N of the liquid crystal panel 11 in turn when displaying the second image on the liquid crystal panel 11. Since the front light 13 lights up simultaneously over the entire screen after the image data has been applied to all the gate lines 1 to N in turn, the second image is simultaneously displayed on the entire screen 11b of the liquid crystal panel 11.

[0019]

After that, the pixel driving circuit 16 alternately displays the first and second images on the liquid crystal panel 11 in the above-mentioned way, and the front lights 12 and 13 are made to alternately light up.

In this case, when the pixel driving circuit 16 makes the frequency of the alternately writing of the first and second images into the plurality of gate lines match with the frequency of the alternately switching on of the front lights 12 and 13 so that they are equal to a frequency of 60Hz or more (i.e., 120Hz or more in all), the viewer A can look at the first image which blinks at the frequency of 60Hz or more while the viewer B can look at the second image which blinks at the frequency of 60Hz or more.

However, it is to be noted that human beings cannot recognize any blink with a frequency of 60Hz or more as blink, but recognizes it as an image

being displayed continuously.

[0020]

As can be seen from the above description, in accordance with this embodiment 1, the pixel driving circuit 16 alternately displays a first image and a second image on the liquid crystal panel 11, and the front light 12 is made to light up while the first image is displayed on the liquid crystal panel by the pixel driving circuit 16 and the front light 13 is made to light up while the second image is displayed on the liquid crystal panel by the pixel driving circuit 16. Therefore, the present embodiment offers an advantage of being able to enable a viewer A to look at the first image and to enable a viewer B to look at the second image different from the first image.

Therefore, the information equipment is effective especially for a case where there is a necessity to prevent the viewer B from looking at the image which the viewer A is looking at. Furthermore, the information equipment makes it possible to precisely provide characters or the like for the viewers A and B, respectively.

[0021]

Furthermore, in accordance with this embodiment 1, when displaying the first or second image on the liquid crystal panel 11, the pixel driving circuit 16 applies the image data about the image to be displayed on the liquid crystal panel 11 to the plurality of gate lines 1 to N of the liquid crystal panel in turn, and the front light 12 or 13 is made to light up after the image data has been applied to all the gate lines 1 to N in turn. Therefore, the present embodiment offers another advantage of being able to display the image simultaneously over the entire screen of the liquid crystal panel 11.

[0022]

In addition, in accordance with this embodiment 1, the liquid crystal panel 11 is provided with the liquid crystal cell 21 having a plurality of pixels, the pair of transparent glass substrates 22 which sandwich the liquid crystal cell 21, and the pair of polarizing plates 24 placed outside the pair of transparent glass substrates 22. Therefore, the present embodiment offers a further advantage of being able to provide the liquid crystal panel 11 having the screens 11a and 11b.

[0023]

Embodiment 2.

In above-mentioned embodiment 1, each of the front lights 12 and 13 is provided with a single light source, and, when the single light source lights up, each of the front lights 12 and 13 simultaneously lights up over the entire screen of the liquid crystal panel 11. As an alternative, each of the front lights 12 and 13 can be provided with a plurality of light sources. In this case, the plurality of light sources can be made to light

up in order that they are arranged from an upper part of the screen to a lower part of the screen in synchronization with writing of the image to the plurality of gate lines of the liquid crystal panel 11 which respectively correspond to parts of the screen starting from the upper part of the screen and ending at the lower part of the screen.

To be more specific, a liquid crystal display in accordance with this embodiment operates as follows.

[0024]

Fig. 4 is a block diagram showing a part of information equipment equipped with the liquid crystal display in accordance with embodiment 2 of the present invention. In the figure, since the same reference numerals as shown in Fig. 1 denote the same components or like components, the explanation of the components will be omitted hereafter.

A timing controller 31, a gate driver 32, and a source driver 33 constitute a pixel driving circuit of this embodiment which corresponds to the pixel driving circuit 16 of Fig. 1.

When receiving image data about a first image and image data about a second image from an image controller 17, the timing controller 31 outputs the image data about the first or second image to the source driver 33 according to an image control signal outputted from the image controller 17, and also outputs a synchronizing signal outputted from the image controller 17 to the gate driver 32 and source driver 33. The timing controller 31 further outputs a light control signal outputted from the image controller 17 to a lighting control unit 45.

[0025]

The gate driver 32 selects a gate line to which the source driver 33 can output the image data on the basis of the synchronizing signal outputted from the image controller 17 one by one from the plurality of gate lines.

The source driver 33 operates on the basis of the synchronizing signal outputted from the image controller 17 so as to apply the image data to each pixel of the gate line selected by the gate driver 32.

[0026]

The plurality of light sources 41 to 44, lighting control unit 45, and a light guiding plate for front light 46 constitute a front light which corresponds to each of the front lights 12 and 13 of Fig. 1.

When receiving the light control signal from the timing controller 31, the lighting control unit 45 makes the plurality of light sources 41 to 44 light up in turn.

The light guiding plate for front light 46 has an array of reflecting prisms 46a each of which reflects light emitted out of each of the plurality of light sources 41 to 44, as shown in Fig. 5, and each reflecting prism 46a is extending in a direction parallel to the direction in which the plurality of light sources 41 to 44 are aligned.

Fig. 5(a) is an explanatory diagram showing the light guiding plate for front light 46, and Fig. 5(b) is a side view showing the light guiding plate for front light 46.

[0027]

Next, the operation will be explained.

For example, when a user operates the mobile phone so as to provide an instruction for enabling a viewer A to look at a first image and enabling a viewer B to look at a second image to the image controller 17 of the mobile phone, as in the case of above-mentioned embodiment 1, the image controller 17 outputs the image data about the first image and the image data about the second image to the timing controller 31 of the pixel driving circuit 16, and also outputs an image control signal for instructing an alternate display of the first and second images to the timing controller 31.

The image controller 17 also outputs a light control signal for controlling the switching on and off of each of the front lights 12 and 13 to the timing controller 31.

[0028]

When receiving the image data about the first image and the image data about the second image from the image controller 17, the timing controller 31 of the pixel driving circuit 16 outputs the image data about the first or second image to the source driver 33 according to the image control signal outputted from the image controller 17.

In other words, the timing controller 31 alternately outputs the image data about the first image and the image data about the second image to the source driver 33 according to the image control signal outputted from the image controller 17.

The timing controller 31 further outputs a synchronizing signal outputted from the image controller 17 to both the gate driver 32 and source driver 33 and also outputs the light control signal outputted from the image controller 17 to the lighting control unit 45.

[0029]

The gate driver 32 of the pixel driving circuit 16 selects a gate line to which the source driver 33 can output the image data from the plurality of gate lines one by one according to the synchronizing signal outputted from the image controller 17.

In other words, the gate driver 32 operates on the basis of the synchronizing signal outputted from the image controller 17 so as to select a gate line to which the source driver 33 can output the image data from the plurality of gate lines one by one in the order of the gate line 1 -> the gate line 2 -> the gate line 3-> ... -> the gate line N-1 -> the gate line N.

[0030]

When receiving the image data about the first image from the timing

controller 31, the source driver 33 of the pixel driving circuit 16 operates on the basis of the synchronizing signal outputted from the image controller 17 so as to display the first image on the liquid crystal panel 11 by applying the image data about the first image to each pixel of the gate line selected by the gate driver 32.

In other words, the source driver 33 operates on the basis of the synchronizing signal outputted from the image controller 17 to display the first image on the liquid crystal panel 11 by applying the image data about the first image to each pixel of the gate line which is selected from the plurality of gate lines one by one in the order of the gate line 1 -> the gate line 2 -> the gate line 3-> ... -> the gate line N-1 -> the gate line N.

[0031]

At this time, when receiving the light control signal from the timing controller 31, the lighting control unit 45 of the front light 12 makes the plurality of light sources 41 to 44 light up in turn while the first image is displayed on the liquid crystal panel 11.

As a result, since the light guiding plate for front light 46 of the front light 12 reflects light emitted out of each of the plurality of light sources 41 to 44 toward the liquid crystal panel 11, the viewer A can look at the first image currently being displayed on the screen 11a of the liquid crystal panel 11 through the transparent cover 14.

In other words, as shown in Fig. 4, since the light emitted out of each of the plurality of light sources 41 to 44 travels through the light guiding plate for front light 46 in a direction which is substantially parallel to the plurality of gate lines, an illuminated region which is parallel to the plurality of gate lines appears. Therefore, the entire screen can be illuminated in a state where a delay between the writing of the image data into the panel and the switching on of each light source is nearly equal.

Since the plurality of light sources 41 to 44 of the front light 13 are all switched off, the viewer B cannot look at the first image currently being displayed on the screen 11b of the liquid crystal panel 11 through the transparent cover 15.

[0032]

Here, Fig. 6 is an explanatory diagram showing a timing at which the first and second images are alternately written. In the figure, the horizontal axis shows time and the vertical axis shows the transmissivity of each pixel of each of the plurality of gate lines 1 to N.

As can be seen from Fig. 6, the source driver applies the image data about the first image to the plurality of gate lines 1 to N of the liquid crystal panel 11 in turn when displaying the first image on the liquid crystal panel 11. Since the plurality of light sources are switched on in order

that they correspond to the plurality of gate lines to which the image data is sequentially applied, respectively, that is, since they are switched on in order of the light source 41 -> the light source 42 -> the light source 43 -> the light source 44, the time which elapses until the front light lights up since the image data has been applied to each pixel of each of the plurality of gate lines 1 to N is nearly equal. Therefore, the front light is switched on in a state where each pixel of the plurality of gate lines 1 to N is stabilized, and the brightness unevenness in the entire screen of the liquid crystal panel 11 can be improved. Therefore, the entire screen of the liquid crystal panel can provide bright and stable gradations.

[0033]

After the first image is displayed on the liquid crystal panel 11 as mentioned above, the gate driver 32 of the pixel the driving circuit 16 selects a gate line to which the source driver 33 can output the image data from the plurality of gate lines one by one according to the synchronizing signal outputted from the image controller 17 after the lighting control unit 45 of the front light 12 switches off the light source 41 according to the light control signal.

In other words, the gate driver 32 operates on the basis of the synchronizing signal outputted from the image controller 17 so as to select a gate line to which the source driver 33 can output the image data from the plurality of gate lines one by one in the order of the gate line 1 -> the gate line 2 -> the gate line 3-> ... -> the gate line N-1 -> the gate line N.

[0034]

When receiving the image data about the second image from the timing controller 31, the source driver 33 of the pixel driving circuit 16 operates on the basis of the synchronizing signal outputted from the image controller 17 so as to display the second image on the liquid crystal panel 11 by applying the image data about the second image to each pixel of the gate line selected by the gate driver 32.

In other words, the source driver 33 operates on the basis of the synchronizing signal outputted from the image controller 17 to display the second image on the liquid crystal panel 11 by applying the image data about the second image to each pixel of the gate line which is selected from the plurality of gate lines one by one in the order of the gate line 1 -> the gate line 2 -> the gate line 3-> ... -> the gate line N-1 -> the gate line N.

[0035]

At this time, when receiving the light control signal from the timing controller 31, the lighting control unit 45 of the front light 13 makes the plurality of light sources 41 to 44 of the front light 13 light up in turn while the second image is displayed on the liquid crystal panel 11.

As a result, since the light guiding plate for front light 46 of the front light 13 reflects light emitted out of each of the plurality of light sources 41 to 44 toward the liquid crystal panel 11, the viewer B can look at the second image currently being displayed on the screen 11b of the liquid crystal panel 11 through the transparent cover 15.

In this case, since the plurality of light sources 41 to 44 of the front light 12 are not switched on while the second image is displayed at an overlapped position, the viewer A cannot look at the second image currently being displayed on the screen 11a of the liquid crystal panel 11 through the transparent cover 14.

[0036]

As can be seen from Fig. 6, the source driver applies the image data about the second image to the plurality of gate lines 1 to N of the liquid crystal panel 11 in turn when displaying the second image on the liquid crystal panel 11. Since the plurality of light sources are switched on in order that they correspond to the plurality of gate lines to which the image data is sequentially applied, respectively, that is, since they are switched on in the order of the light source 41 -> the light source 42 -> the light source 43 -> the light source 44, the time which elapses until the front light lights up since the image data has been applied to each pixel of each of the plurality of gate lines 1 to N is nearly equal. Therefore, the front light is switched on in a state where each pixel of the plurality of gate lines 1 to N is stabilized, and the brightness unevenness in the entire screen of the liquid crystal panel 11 can be improved. Therefore, the entire screen of the liquid crystal panel can provide bright and stable gradations.

[0037]

After that, the pixel driving circuit 16 alternately displays the first and second images on the liquid crystal panel 11 in the above-mentioned way, and the front lights 12 and 13 are made to alternately light up.

In this case, when the pixel driving circuit 16 makes the frequency of the alternately writing of the first and second images into the plurality of gate lines match with the frequency of the alternately switching on of the front lights 12 and 13 so that they are equal to a frequency of 60Hz or more, as in the case of above-mentioned embodiment 1, the viewer A can look at the first image which blinks at the frequency of 60Hz or more while the viewer B can look at the second image which blinks at the frequency of 60Hz or more.

[0038]

In this embodiment 2, the light guiding plate for front light 46 has the array of reflecting prisms 46a each of which reflects light emitted out of each of the plurality of light sources 41 to 44, as previously mentioned. As an alternative, the light guiding plate for front light 46 can have a sawtooth-shaped prism 46b or a lens 6c which is added to each of the plurality

of light sources 41 to 44, as shown in Figs. 7 and 8, so that the prism 46b or lens 46c can make rays of light emitted out of each of the plurality of light sources 41 to 44 travel in a nearly-parallel direction within the light guiding plate for front light 46.

[0039]

Further, in this embodiment, the writing of image data into the LCD panel is performed for every gate line, as previously mentioned. However, the writing of image data into the LCD panel is not limited to this example. In a case where the writing of image data into the LCD panel is performed for every pixel, the same action as mentioned above can be implemented if the writing of image data into the LCD panel for each pixel is performed in a direction parallel to boundaries between the illuminated regions in which each front light lights up.

Furthermore, although each pixel of the liquid crystal panel has sub pixels having color filters of different colors, it is desirable that the color filters are aligned in a direction perpendicular to the reflecting prism 46a in order to suppress occurrence of moiré fringes with each front light.

[BRIEF DESCRIPTION OF THE DRAWINGS]

[0040]

[Fig. 1] This is a cross-sectional view showing information equipment equipped with a liquid crystal display in accordance with embodiment 1 of the present invention.

[Fig. 2] This is a cross-sectional view showing a liquid crystal panel of the liquid crystal display in accordance with embodiment 1 of the present invention.

[Fig. 3] This is an explanatory diagram showing a timing at which a first image and a second image are alternately written.

[Fig. 4] This is a block diagram showing a part of information equipment equipped with a liquid crystal display in accordance with embodiment 2 of the present invention.

[Fig. 5] (a) is an explanatory diagram showing a light guiding plate for front light 46, and (b) is a side view showing the light guiding plate for front light 46.

[Fig. 6] This is an explanatory diagram showing a timing at which a first image and a second image are alternately written.

[Fig. 7] This is an explanatory diagram showing the light guiding plate for front light.

[Fig. 8] This is an explanatory diagram showing the light guiding plate for front light.

[DESCRIPTION OF THE REFERENCE NUMERALS]

[0041]

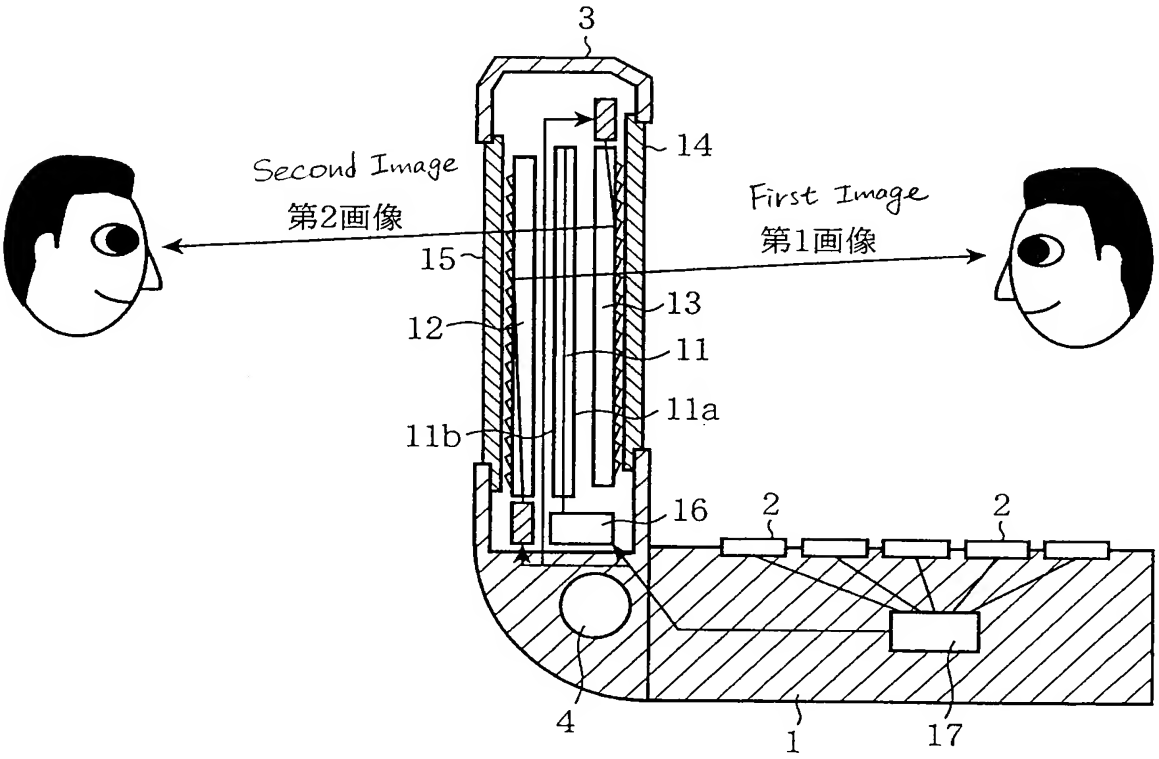
1 ... main body of mobile phone; 2 ... function switch; 3 ... display

unit; 4 ... hinge; 11 ... liquid crystal panel; 12 ... front light (the first front light); 13 ... front light (the second front light); 14 ... transparent cover; 15 ... transparent cover; 16 ... pixel driving circuit; 17 ... image controller; 21 ... liquid crystal cell; 22 ... transparent glass substrate; 23 ... sealing agent; 24 ... polarizing plate; 31 ... timing controller (pixel driving circuit); 32 ... gate driver (pixel driving circuit); 33 ... source driver (pixel driving circuit); 41 to 44 ... light source (the first front light and the second front light); 45 ... lighting control unit (the first front light and the second front light); 46 ... light guiding plate for front light (the first front light and the second front light); 46a ... reflecting prism; 46b ... prism; and 46c ... lens.

【書類名】図面 [Name of the Document] Drawings

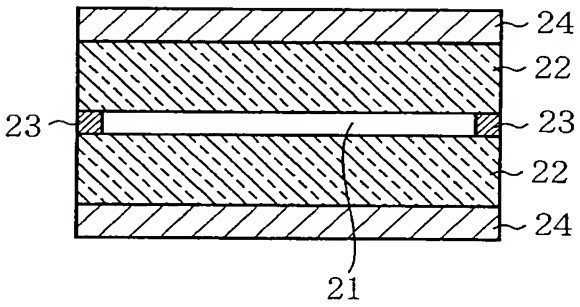
【図１】

[Fig. 1]



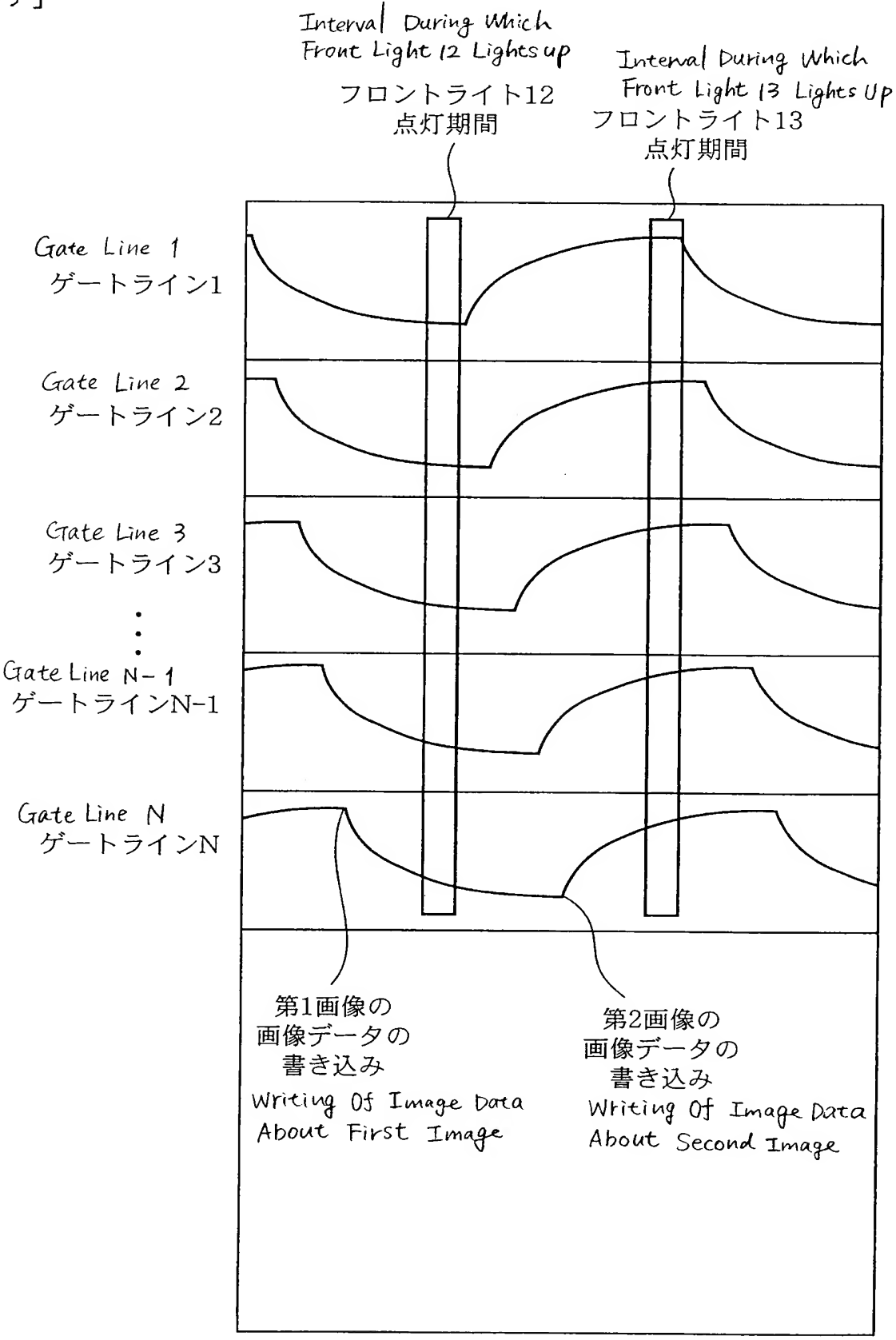
【図２】

[Fig. 2]



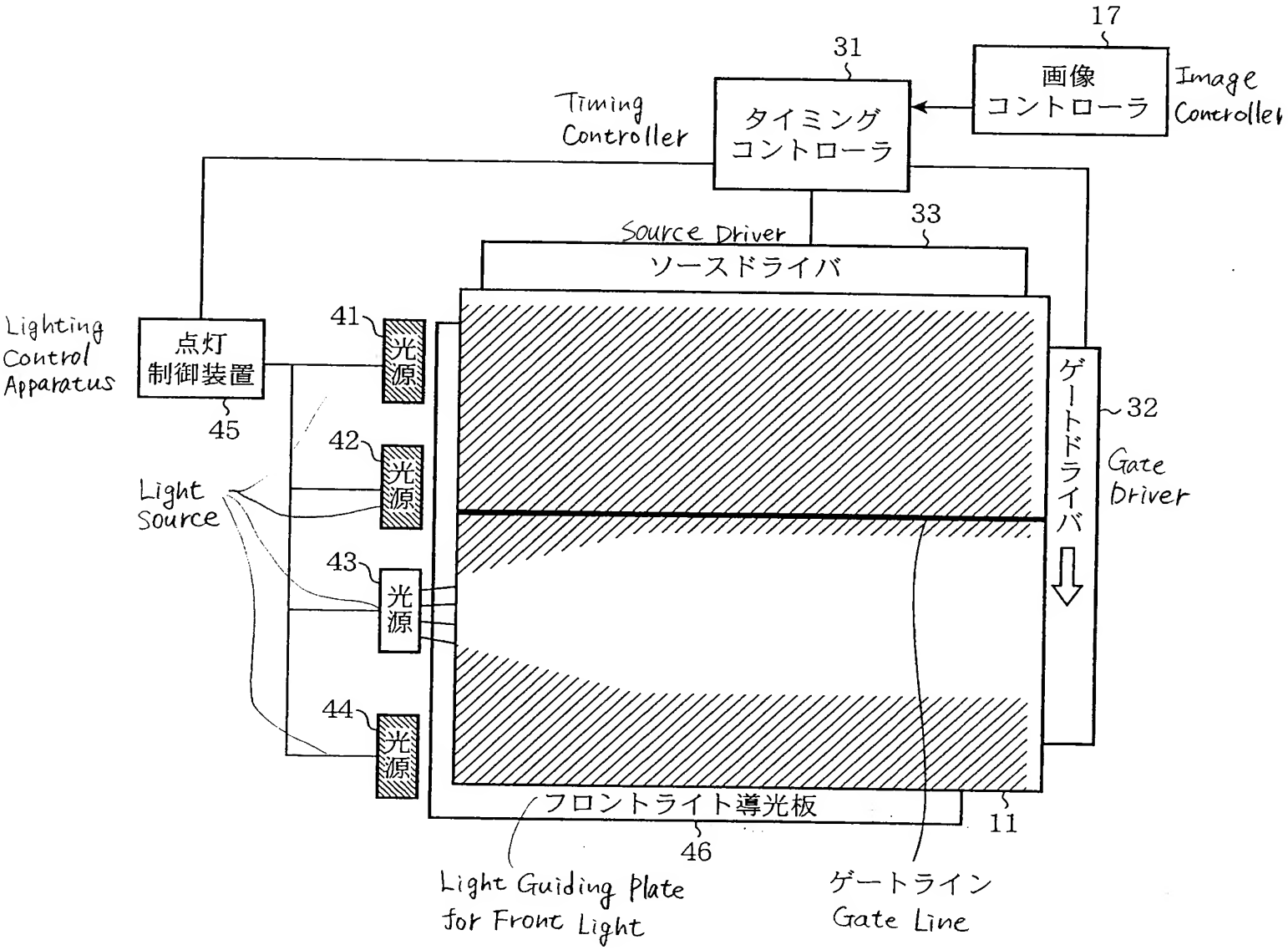
【図３】

[Fig. 3]


Interval During Which Front Light 12 Lights up
フロントライト12 点灯期間
Interval During Which Front Light 13 Lights Up
フロントライト13 点灯期間
Gate Line 1
ゲートライン1
Gate Line 2
ゲートライン2
Gate Line 3
ゲートライン3
Gate Line N-1
ゲートラインN-1
Gate Line N
ゲートラインN
第1画像の 画像データの 書き込み
Writing Of Image Data About First Image
第2画像の 画像データの 書き込み
Writing Of Image Data About Second Image

【図４】

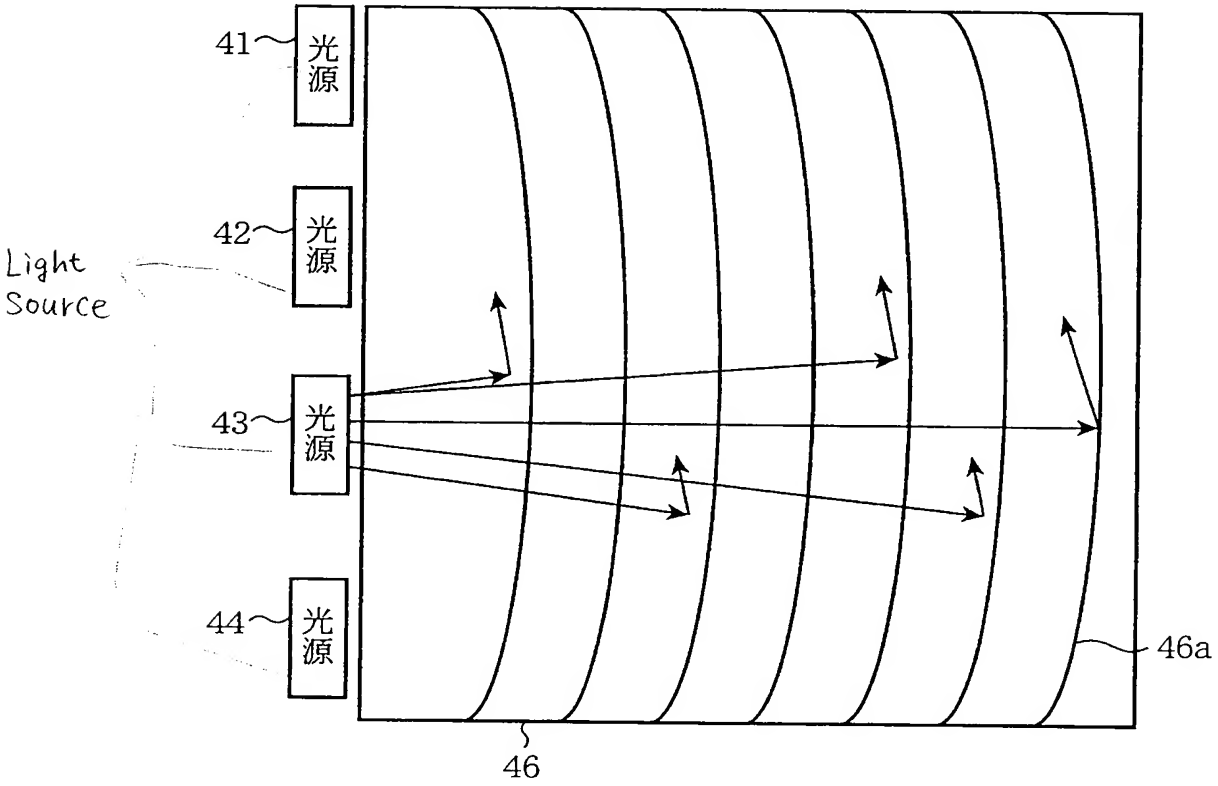
[Fig. 4]


17
画像
コントローラ
Image
Controller
31
タイミング
コントローラ
Timing
Controller
33
Source Driver
ソースドライバ
Lighting
Control
Apparatus
点灯
制御装置
45
41
光源
42
光源
Light
Source
43
光源
44
光源
ゲートドライバ
32
Gate
Driver
フロントライト導光板
11
46
Light Guiding Plate
for Front Light
ゲートライン
Gate Line

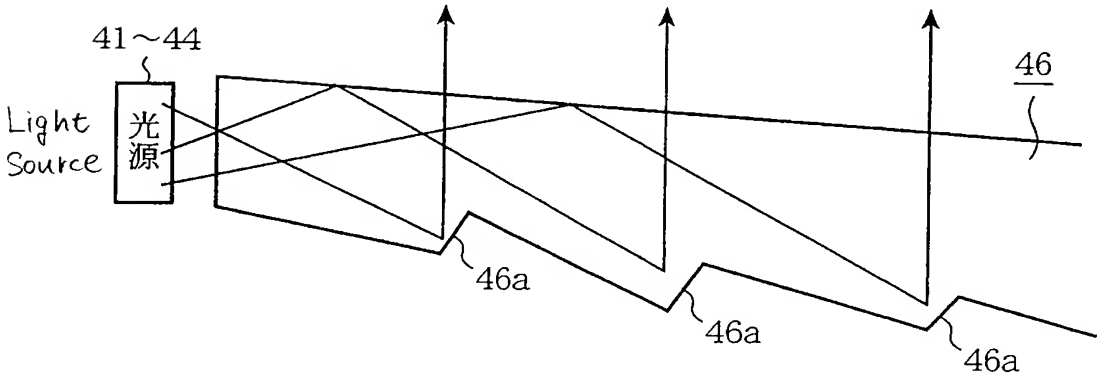
【図５】

[Fig. 5]

(a)

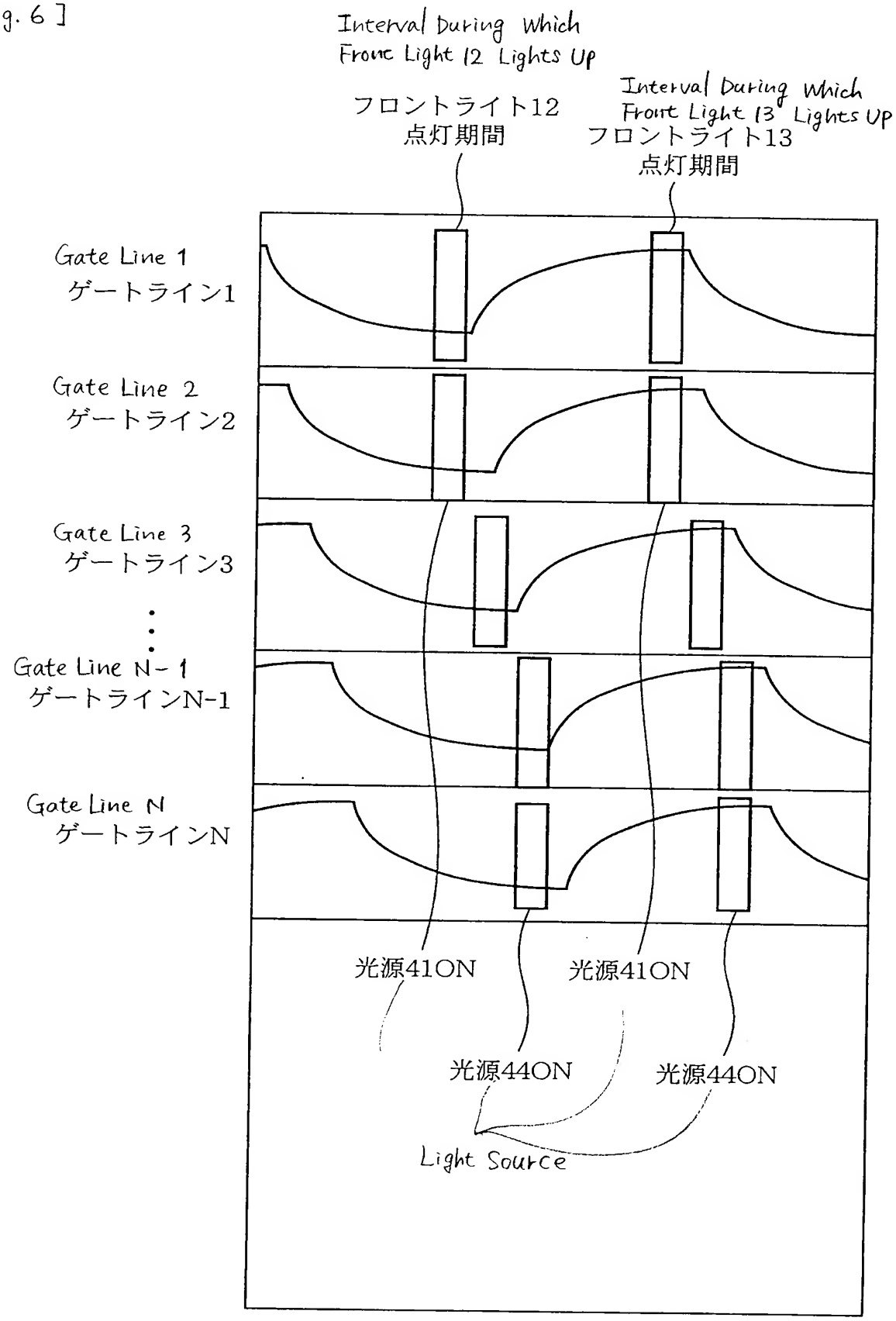

41
光源
42
光源
Light Source
43
光源
44
光源
46a
46

(b)


41～44
Light Source
光源
46
46a
46a
46a

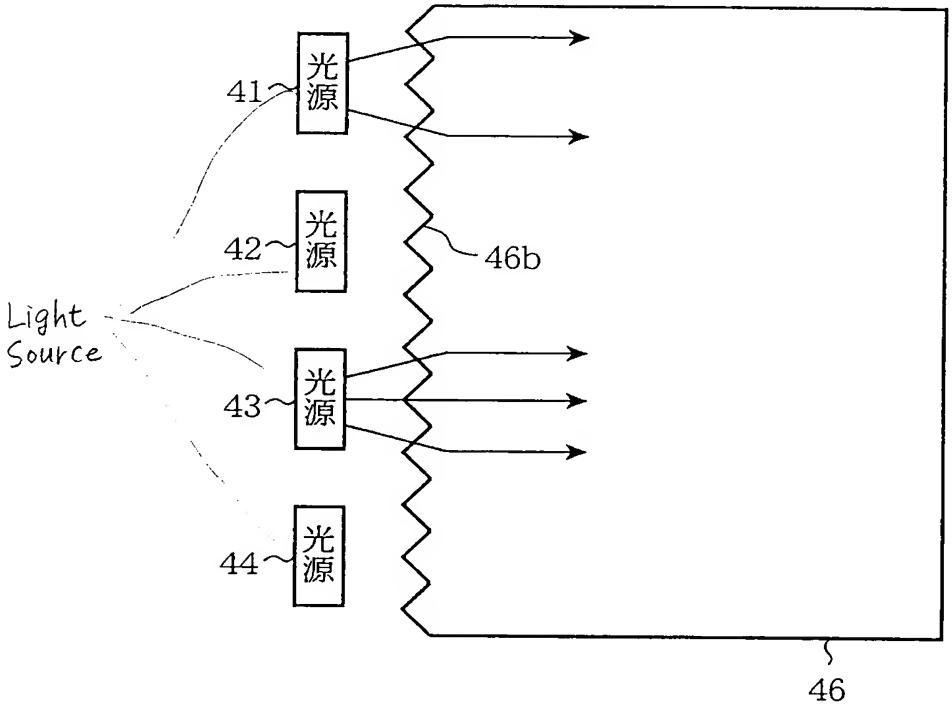
【図６】

[Fig. 6]


Interval During Which Front Light 12 Lights Up
フロントライト12 点灯期間
Interval During Which Front Light 13 Lights Up
フロントライト13 点灯期間
Gate Line 1
ゲートライン1
Gate Line 2
ゲートライン2
Gate Line 3
ゲートライン3
Gate Line N-1
ゲートラインN-1
Gate Line N
ゲートラインN
光源41ON
光源41ON
光源44ON
光源44ON
Light Source

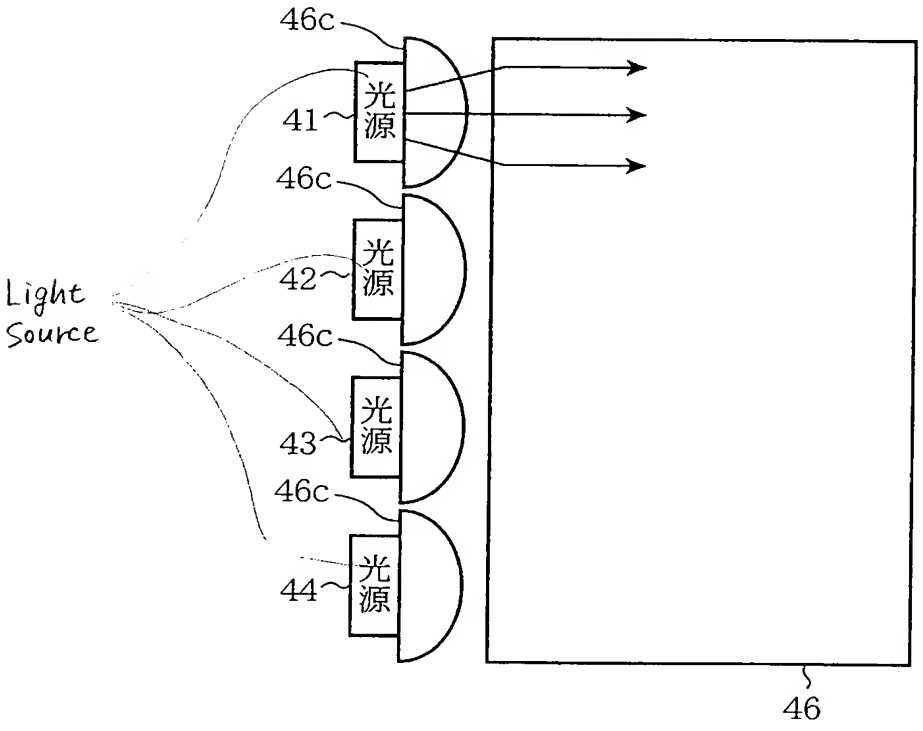
【図７】

[Fig. 7]



【図８】

[Fig. 8]



[NAME OF THE DOCUMENT] ABSTRACT OF THE DISCLOSURE

[ABSTRACT]

[SUBJECT] To provide a liquid crystal display which can display another image different from an image currently being displayed on one screen on the other screen.

[SOLVING MEANS]

In a liquid crystal display, a pixel driving circuit 16 alternately displays a first image and a second image on a liquid crystal panel 11. A front light 12 lights up while the first image is displayed on the liquid crystal panel by the pixel driving circuit 16, and another front light 13 lights up while the second image is displayed on the liquid crystal panel by the pixel driving circuit 16. As a result, the liquid crystal display enables a viewer B to look at the second image different from the first image which it provides for a viewer A.

[SELECTED DRAWING] Fig. 1